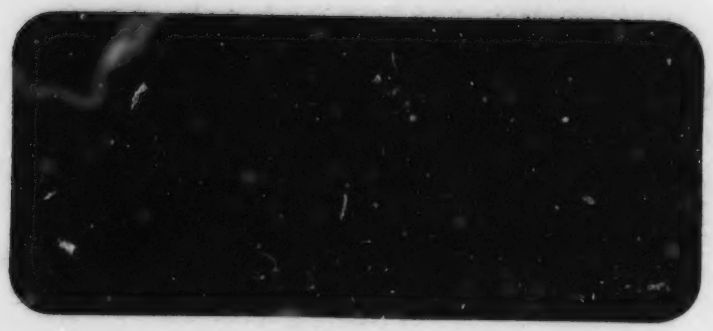
SUMMARY OF THE PROCEEDINGS OF THE WORKSHOP ON WATER QUALITY ASSESSMENT IN B.C.

MAY 15 - 17, 1990

Province of British Columbia

BC Environment

WATER MANAGEMENT DIVISION



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MAY 15 - 17, 1990

SPONSORED BY:

THE COORDINATING COMMITTEE
OF THE
CANADA-BRITISH COLUMBIA WATER QUALITY
MONITORING AGREEMENT

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EXECUTIVE SUMMARY

A workshop on the future information needs for water quality assessment in British Columbia was held in Parksville, B.C. on May 15 to 17, 1990. The workshop was co-sponsored by Environment Canada and the British Columbia Ministry of Environment, and it brought together water quality specialists from British Columbia and across Canada.

The workshop began with a keynote address by Mr. Stuart McKenzie of the United States Geological Survey (USGS). His talk described the overall water quality monitoring objectives and experience of the USGS with specific reference to the Yakima River Basin Water Quality Assessment Pilot Study. The USGS commits considerable funds to its projects, for example, nearly $10 million is spent annually on the Basin study. Also key to the success of USGS projects is the establishment of a Liaison Committee to facilitate communication between USGS and other scientists. managers, local governments, community agencies and citizen groups. The data collection approach for USGS projects is phased over a ten year cycle and includes: the development of a conceptual model of water quality using existing data; reconnaissance sampling to further develop the monitoring program; a three year intensive sampling program; one year of report preparation; and four years of low level sampling effort. The cycle repeats itself with a year of planning for the next series of intensive sampling.

Following the keynote presentation, the participants formed work groups to identify information needs and to develop a model for water quality assessment related to these five areas:

- urbanization and municipal discharges;
- pulp, paper and lumber manufacturing;
- mining, smelting and related industries;
- agriculture and forestry; and
- atmospheric deposition.

The major issues for water quality assessment for the 1990's in British Columbia, identified by the experts at the workshop included:

1. The need to maintain an up-to-date and readily accessible database on water quality.

2. Timely reporting of environmental monitoring to all stakeholders (government, industry, and the public).

3. Increased research in targeted areas, especially those likely to have new environmental importance in coming years.

4. Support for training of students, practising scientists, managers and technicians in water quality issues.

5. Support for partnerships between government and industry in all areas of water quality monitoring, including information exchange, planning and funding.

6. Facilitation of active public participation in all stages of the water quality monitoring process.

7. Commitment to quality assurance and quality control programs.

Evaluations of the workshop showed that the discussion between the participants in the work groups was most valuable. Considerable consensus and commitment to action by the participants resulted. The excellent work by many of the participants in water quality issues was acknowledged.

Based on the success of the workshop, there was unanimous support that future workshops be planned to focus on specific issues arising from the recommendations. Public participation in future workshops was recognized as desirable.

1.0 INTRODUCTION

Environment Canada and the British Columbia Ministry of Environment co-sponsored a workshop on the future information needs for water quality assessment in British Columbia. The workshop, initiated by the Coordinating Committee of the Canada-British Columbia Water Quality Monitoring Agreement, was held May 15 to 17, 1990, at the Island Hall Resort in Parksville, B.C. Twenty-four water quality specialists from throughout British Columbia and eastern Canada attended the invitational workshop.

The workshop provided a forum for the discussion of significant water quality issues of the 1990's in British Columbia. The purpose was to identify the information requirements and develop a model for water quality assessments.

The participants met in work groups to review the major sources or impact activities which result in water quality problems. The work groups were asked to include a number of issues in their deliberations including:

- existing knowledge and major gaps in understanding;
- monitoring and assessment program requirements;
- data storage and handling needs;
- reporting requirements; and
- recommendations for future programs.

This report describes the workshop process and summarizes the major points made during the two and a half days. Formal workshop proceedings were not prepared. The list of participants and the workshop agenda are presented in Appendix 1 and 2, respectively.

2.0 WORKSHOP FORMAT

The workshop began the first morning with a keynote presentation by Mr. Stuart McKenzie, Senior Hydrologist with the United States Geological Survey (USGS) in Portland, Oregon. The title of Mr. McKenzie's talk was "The Evolution of the United States Geological Survey Water Quality Programs". Mr. McKenzie spoke for about ten hours over the three days, detailing the overall water quality monitoring objectives and experience of the USGS, and describing the specific programs that are under way in the Yakima River Basin Water Quality Assessment Pilot Study. Mr. McKenzie was present throughout the workshop, contributing greatly to the work groups and plenary sessions that followed his keynote address.

To facilitate discussion by the participants, five work groups were formed to address the following areas:

- Urbanization and municipal discharges;
- Pulp, paper and lumber manufacturing;
- Mining, smelting and related industries;
- Agriculture and forestry; and
- Atmospheric deposition.

The five work groups met the first afternoon to discuss their respective topics. The agenda for this part of the workshop deliberately was kept unstructured to allow participants the freedom to consider a wide range of issues. Summaries of the deliberations of the five work groups were then presented for consideration by all participants in a plenary session conducted the next morning.

During the second afternoon, discussions continued in the five work groups, which were again shared at the final plenary session held on the third morning.

3.0 KEYNOTE PRESENTATION

The following summary was prepared from the handout material that Mr. McKenzie provided, as well as from notes taken during his presentation. Audiotapes of the workshop were also reviewed when compiling this review. The selection of the information that follows was based on its relevance to the outcomes of the work group discussions.

3.1 United States Geological Survey

The USGS is responsible for a national data collection program as well as a number of specific, regional water quality assessment programs. In 1988 the USGS had a budget of $662 million and approximately 8500 employees within its five divisions. One of the divisions, the Water Resources Division, has as its mission, "to improve the understanding of hydrologic processes such that the Water Resources Division can quantitatively explain the response of systems to stresses (natural or manmade)".

Two programs under the Water Resources Division are the National Research Program and the Operational Program Research. Activities in the National Research Program are directed towards gaining new knowledge through longer term, process-oriented studies in areas of general significance. Operational Program Research work focuses on new applications to specific problems in specific geographical areas over a finite period of time. The National Research Program is separated into several study areas including: surface water chemistry, groundwater chemistry, sediment and geomorphic processes, surface water hydrology, groundwater hydrology and ecology.

Surface water activities, and especially the collection of stream flow data, have been under way since 1944 with the initiation of the national Water Conditions Program. The value of these data to other user groups was stressed, particularly because collection of this information can not be replaced by the use of models. There is also a trend towards the collection of real-time stream flow data. Groundwater supplies and analysis of regional aquifer systems is also receiving considerable attention in response to recent water shortages in some regions of the United States.

The USGS maintains a National Training Centre offering continuing education in surface water, groundwater and water quality. Subjects such as measurement techniques, data processing and interpretation of results are covered in a revolving calendar of 45 courses. Questions about course offerings should be directed to Mr. Joe Willmon, National Training Centre, United States Geological Survey, Denver Federal Centre, Building 53, Lakewood, Colorado, 80225 (telephone: 303-236-4932). The USGS also operates a National Water Quality Assessment Program which provides baseline data on trends.

The National Surface-water Quality Networks (NASQAN) have the objectives of defining long term trends in water quality and accounting for constituent flux between major river basins, to the Great Lakes and off the continent (mouth of major coastal rivers). The NASQAN use a large number of fixed stations sampling at set intervals for specific variables.

The objective of BENCHMARK is to define the status and trends in physical hydrology and water quality in areas unaffected directly by land use activities. One component of this program is the selection of a quality assurance site (Crater Lake) as a check on laboratory procedures.

The objectives of the NATIONAL TRENDS NETWORK are to characterize the chemical composition of atmospheric precipitation regionally and nationwide and to detect temporal and spatial trends in the chemical composition of atmospheric precipitation.

Data from the NAWQA program were used by Mr. McKenzie to show the proportion of waterbodies in the United States impaired by various sources of contaminants. For example, agricultural runoff is estimated to impair 55% of the total river length, and 59% of the total lake area, while municipal effluents and urban runoff are estimated to affect 29% of the river length and 43% of the lake area. By contrast, industrial contaminants and resource extraction are estimated to impair only 9% and 13% of river length, and only 8% and 4% of lake area, respectively.

3.2 National Water Quality Assessment Program (NAWQA)

The data can also are grouped by contaminants, rather than by source. Mr. McKenzie presented results which estimated that nutrients impair 27% of river length, 49% of lake area and 50% of estuary area, while siltation affects 42% of river length, 25% of lake area, but a negligible proportion of estuary area. Nineteen percent of river length and 48% of estuary area is impaired by pathogens while biochemical oxygen demand impaired 25% of lake area and 29% of estuary area. There is little impairment of lake area by pathogens, or river length by biochemical oxygen demand. Mr. McKenzie explains that there has not been sufficient data collected to estimate the degree of impairment resulting from synthetic organics. In the past there was little interest in these variables but their measurement is expected to increase significantly in the next decade.

Biological Programs

Studies on contaminants associated with suspended sediments are also expected to increase in the next decade. Programs will focus on the transport and deposition of sediments, sediment response to land use changes and pollutant transport.

The biological program at NAWQA has set these objectives for a monitoring program.

1. To document the current status of the biological community (spatial variation).

2. To assess long term changes in the biological community (temporal variation).

3. To interpret spatial and temporal patterns in biological communities with respect to physical and chemical characteristics of the environment.

4. To provide background information to support other biological measurements.

5. To obtain improved understanding of the functioning of river systems.

The criteria for the selection of a particular ecological measure within these objectives includes: sensitivity to anthropogenic change; low natural variability; meaningful biological phenomena; and national consistency.

To review the overall quality of the habitat, the biological program follows a three step process: a reconnaissance survey, a habitat evaluation, and a true ecological survey. A **reconnaissance survey** is carried out to select stations and to determine the spatial variability and suitability of sites and to obtain some preliminary biological and chemical data. The **habitat evaluation** includes a physical description of the reach and sample site selection. The **ecological survey** provides an interpretation of water quality events and trends. Fish, macro-invertebrates, algae, habitat, and special studies are included in the ecological component.

Contaminants in Tissues

For the study of accumulation of contaminants in body tissues, the research questions are: Is the contaminant present? Does it bioaccumulate? Does it biomagnify? Is it a problem?

Tissues are analyzed to:

- determine occurrence, and spatial and temporal distribution of contaminants;
- obtain information on fate;
- assess contaminant bioavailability;
- develop national data base;
- assess potential for human exposure; and
- develop bioassessment procedures.

The tissue analysis program conducts reconnaissance level sampling at sites where contaminants are expected, and synoptic sampling to determine the impact from land use activities (reference sites and affected sites).

Trace Elements

Trace elements are monitored to determine:

- the spatial distribution for both dissolved and bottom material;
- the seasonal variability of dissolved trace elements and those associated with suspended material;
- the bioavailability of dissolved and whole-water recoverable trace elements;
- the sources and/or causes of dissolved and suspended loads; and
- the effects of trace elements on ecological communities and/or bioaccumulation and biomagnification.

Trace element studies under NAWQA include the analysis in streambed sediments of a suite of 45 elements, total digestion, on material less than .062 mm size. In the Yakima River Basin Study (see Section 3.3), the Geologic Division looked at 193 sites randomly selected, including 45 sites where historical data suggested enrichment, and 90 QA/QC samples. The Water Resources Division looked at 90 sites related to potential sources, with 25 QA/QC samples. Evaluating quality assurance for bottom sediments was difficult because there were no artificial standards available. (In Canada, reference sediments are available for some contaminants.) The laboratory can only check on precision and other samples of known quantity.

The Yakima River Basin Study also looked at 42 elements in the suspended sediments (monthly sampling plus storm sampling), and 17 dissolved trace elements (Cd, Cu, Hg, Pb done monthly, the rest done during three synoptic samplings related to water flows).

Trace organic compounds are of recent concern but the historical data base is very poor, both in quantity and with respect to quality control. For these reasons, some effort is required to design a sampling program. The overall objectives for the assessment of trace organic compounds are to determine their occurrence and seasonal variability, spatial distribution, and relationship with land and water use activities.

The first step toward designing a basin survey is to determine sampling strategies based on a knowledge of the study area and of organic contaminants in general. These questions are asked.

- Where to sample?
- When to sample?
- What constituents to sample?
- What medium to sample (water, suspended sediment, or bed material)?
- How to collect the data (e.g., separate the sediment from the water)?

Once these strategies are set, synoptic samplings are done to determine the relation between selected land uses and trace organic concentrations in bed material; as well as the seasonal variability, spatial variability and transport of these trace organic compounds.

3.3 Yakima River Basin (Washington) Pilot Study

This study, conducted under the NAWQA program, is one of a number of applied research programs done on watersheds throughout the United States. The objectives are:

- to describe the spatial variability of surface water quality;
- to determine temporal variations (seasonal and long term);
- to identify cause and effect processes;
- to simulate management alternatives; and
- to develop techniques and guidelines that are transferable to other NAWQA programs.

The first task in the Yakima River Basin pilot study, as in all NAWQA projects, was to establish a Liaison Committee in order to facilitate communication between USGS and other scientists, managers, local government, local public and native bands. The Liaison Committee also ensures the study is sensitive to local and regional needs.

An important component of all NAWQA projects is the development of a communication plan. In the Yakima River Basin Study, fact sheets and brochures on study results were prepared; a public information centre was established; periodic public meetings were held, and "state of environment" reports, with summaries for the lay readers, were released.

The water quality issues identified in the Yakima River Basin were:

- pesticide contamination;
- nutrient enrichment from fertilizers;

- algal growth;
- sedimentation from soil erosion;
- low river flows from irrigation diversion;
- elevated stream temperatures;
- treated sewage disposal; and
- irrigation and fisheries users.

The general approach taken in these studies follows:

1. Develop a conceptual model of water quality using existing water and basin data.

2. Use this model to develop NAWQA sampling network and intensive studies.

3. Use NAWQA data to update, redefine and quantify the conceptual model.

The data collection utilizes fixed station monitoring (NASQAN sites), synoptic studies and intensive studies. Fixed station monitoring provides information from six to seven sites, sampled monthly as well as during specific events, such as high flow periods. The fixed station data are used to define seasonality of man-caused and natural events, long term trends, and mass balancing of constituent loads. For three years data are collected, followed by six years with limited collection. This schedule is then repeated. Previous studies have shown that 80 to 90 percent of the interpretive power is retained with this schedule.

Synoptic studies are conducted at a large number of stations over a short time frame (same hydrologic event) to determine the spatial variability. Sites are located upstream and downstream of major land use activities and point sources.

Intensive studies are planned to determine the cause and effect of water quality problems, such as the source, transport, fate and effect of toxic constituents. Mathematical modelling of stream processes that could be used for exploring management alternatives are also planned. Intensive studies often include cooperative funding with other sources or agencies.

The NAWQA basin studies are carried out over a ten year cycle, as shown below:

Year 1	Planning for initial cycle
Year 2	Retrospective analysis using existing data and some reconnaissance sampling
Year 3,4,5	Intensive sampling
Year 6	Report completion
Year 7,8,9,10	Low level sampling
Year 11	Planning for second sampling
Year 12,13,14	Intensive sampling for second cycle

NAWQA has planned for the study of 60 watersheds, similar to the Yakima River Basin. Each basin requires an expenditure of around $9 million per year and an overall commitment of 400 to 500 FTEs (full-time equivalent staff). Up to ten people may be required to work on a project and the general approach is to keep the same people throughout the study.

4.0 WORK GROUP PRESENTATIONS

The following is a summary of the discussions that took place in the five work groups and recommendations that came out of the plenary sessions. Many issues, although initially identified by only one or two work groups, were later adopted as issues for all work groups.

4.1 Present Programs and Data Gaps

Most groups acknowledged that standard monitoring variables are generally well understood. Data on biological oxygen demand, nutrients, suspended solids and major inorganic ions, in water are now available, although historical data against which changes can be compared are lacking in many instances. The lack of adequate baseline information, reflecting natural variability of watershed characteristics, is evident for most water quality programs. Lack of appropriate quality assurance and quality control procedures (QA/QC) also limit the usefulness of the data available.

Few suspended and bottom sediment data are available. The database on body burdens for some biological species is improving but there is essentially no information on the effects of stress and physiological changes. Neither is there information describing ecosystem changes. Traditional bioassays are viewed as having limited value since they are not reflective of what is occurring in the environment. The pathways of contaminants are essentially unknown. The relationship between water quality and flow is poorly understood.

All work groups identified the need for documentation of water uses and the value of the aquatic resources. The importance of developing water quality objectives to meet these use requirements was also highlighted. Information is needed to develop site-specific water quality objectives. A need for linking the value of the information required against the cost of obtaining the data was agreed to be appropriate to all monitoring programs. Similarly, a need to determine the environmental significance of contaminants, beyond that of presence alone, was identified.

4.1.1 Urbanization and municipal discharges

There is a lack of information on sources of contaminants and the impact of multiple discharges in urban areas. In particular, data on the relative contribution of storm water runoff are lacking. There are data gaps with respect to the concentration, pathways and total loading of organic contaminants from municipal discharges and storm water.

4.1.2 Pulp, paper and lumber manufacturing

For pulp effluent, knowledge of organo-chlorine compounds (toxicity, degradation rates and persistence, impact) is considered to be very poor in contrast to more traditional variables. Data for all media (drinking water, surface water, groundwater, sediments, and biota) are required. Similarly, fate and effects of compounds used in lumber treatment are poorly understood.

4.1.3 Mining, smelting and related industries

New mining operations generally have substantial monitoring programs associated with their operations, however, the background information is generally insufficient. At least 24 to 30 months of data are required to monitor adequately and predict mining impacts. In particular, meteorological and hydrological data are generally lacking.

Information on total metals in sediments and tissues is generally sufficient but there is a need to understand overall environmental processes so that predictions on impacts are more reliable. Metal speciation and bioavailability, and the toxicity of metals under field conditions are not well understood. Knowledge of the toxicity of bottom sediments is limited. The environmental consequences of the "chemical soup" that is discharged from these operations requires investigation. The effect of northern climates on metal speciation and toxicity was identified as a major data gap.

4.1.4 Agriculture and forestry

Non-point source discharges make the assessment of the issues related to agriculture and forestry difficult. Documentation of agricultural activities (the location, density, and types of agricultural practices) is not generally available. Consequently, the influence on water quality is difficult to assess and compare with natural events. Total suspended solids was identified as a major issue, with impacts occurring during the generation of the material (stream bank erosion), during transport and at deposition. Most water quality uses (fisheries habitat, domestic water use, recreation, power generation, etc.) are affected by total suspended solids.

4.1.5 Atmospheric deposition

Three spatial scales were proposed: a) 10 to 100 km, mostly affected by urban and industrial emissions, and automobile emissions; b) 100 to 1000 km, where industrial and resource development, smelting, refineries, etc. were the major sources; and, c) greater than 1000 km, which included the global transport of persistent organic compounds (LRTAP, long range transport of atmospheric pollutants). The information base becomes increasingly weaker progressing from the local to the global situation.

There is little information on the resources most at risk by the transport of these pollutants, especially LRTAP compounds. Two principal concerns were identified: the potential impact on human health and, the effect of acidification of aquatic ecosystems. An audit of toxic compounds from industry was lacking, therefore making it difficult to do mass balance analyses.

4.2 Purpose and Types of Monitoring and Assessment

Monitoring can serve a number of functions including:

- assessing long-term trends and documenting background conditions;
- applying compliance (legal) monitoring for specific discharges;
- predicting and detecting the effects of specific activities or developments;
- developing or monitoring water quality objectives;
- documenting irregular events (e.g., through bioaccumulation);
- determining the loading of contaminants in water and sediments;
- providing an early warning of environmental problems;
- protecting public health and promoting public confidence; and
- reporting on the state of environment to the public.

All work groups identified weaknesses in past monitoring programs, brought about primarily because of financial constraints. Specific comments were made on the following limitations.

1. Insufficient number of replicates collected.
2. Insufficient duration of program and frequency of sampling.
3. Inability to document episodic events.
4. Poor or no quality control/quality assurance program.
5. Poor sampling of vertical and horizontal variability.
6. Inadequate ecosystem analysis.

Of particular concern was monitoring to maintain water quality objectives for non-point sources and to establish the connection between urban, forestry or agricultural practices

and impacts on water quality. Before and after comparisons to determine the effects of agricultural practices are almost impossible, because most areas have had ongoing activities for many years. Use of wilderness areas for "background" sites poses the challenge of difficult accessibility. There is some value in upstream/downstream comparisons but stream to stream comparisons are rarely done. The lack of site specific studies can be offset somewhat through model ecosystems as well as computer modelling of watershed events.

Multi-parameter monitoring was seen as important because of the need to confirm trends. On the other hand, research into "surrogate variables" to reduce the costs of monitoring was also recommended.

Water quality objectives were regarded as a key tool. It was recognized that the quality and stability of the economy is linked with the state of the environment. Therefore, all water users must adjust to maintain water quality. While it was agreed that there should be no exceptions or "grandfather" clauses to this process, it was also recognized that some activities (e.g., forestry and agriculture) are presently, to a large extent, exempt from pollution control objectives.

For some specific discharges or activities (e.g., mining exploration), the mechanism for the early identification of problems and for the development of an action plan to address the problems is frequently missing. An example of this is the development of "close out" monitoring and action plans.

Biological testing and monitoring were considered to be essential but present monitoring procedures have problems including a lack of sensitivity and specificity for some contaminants, and natural environmental variability. Sublethal and chronic tests need to be developed to provide more sensitive monitoring tools. Protocols are required for standardized biological tests and the biological testing should complement the chemical testing.

There was general agreement that the development of monitoring programs should have public input. This would go a long way towards improving the credibility of the monitoring programs.

4.3 Data Storage and Handling

A very strong message coming from each work group was the importance of achieving and maintaining an up-to-date and readily accessible database. Desirable features include:

- ability to use unrelated data (e.g., hydrological, demographical, geographical, wildlife, emergency spills, etc.);
- ability to use information from variety of sources (government, industry, and research institutions);
- the inclusion of ancillary information, including all QA/QC data;
- different databases with a common format to promote sharing;
- a protocol to share data sets;
- a directory or inventory of all databases;
- all data available in original, untransformed, state;
- all new data in electronic form; and
- an archive of electronic data established to preserve historical information.

Geographical Information Systems (GIS) were viewed by many as a valuable tool to be used in conjunction with databases. Significant flexibility can be gained in the applications of "overlay" maps through the use of GIS.

Protocols for using and merging different data sets and incorporating QA/QC information into these databases should be developed. The comment was made that even "poor" data have value and nothing should be discarded. Coding to indicate the QA/QC (or lack of such measures) should be incorporated into the database.

Numerical modelling was recommended as having the potential to provide important interpretative and management information. However, one weakness which pertains to numerical modelling, to GIS systems, and to data bases in general, is the lack of in-house expertise (in government) and training programs for scientists, to use these new data management tools.

Ancillary data, such as those associated with land use activities, are difficult to obtain and are often not collected at all. Information on the amount of leaded gas used, the movement and use of hazardous materials, contributions from industries discharging to sewers, and agricultural practices were some examples cited.

4.4 Reporting

Probably the weakest link in the environmental monitoring process is the timely reporting of monitoring information. Many examples of information residing in file cabinets in government offices were given. This is the case for all levels of information from data compilations to state of the environment overview reports. This poor practice has lead to a lack of confidence in the monitoring process by both the public and industry.

Discussions with all work groups provided the following recommendations.

1. Reports must be produced within a reasonable time period.

2. Reports should be complete with sections dealing with interpretation and discussion, conclusions, and recommendations.

3. Reports should include an executive summary.

4. Reports must attempt to assess impacts of activities (risk assessment) e.g., cause and effect.

5. Reports must identify research and development needs.

6. Reports must address social and health issues.

7. A summary report (e.g., a fact sheet) for public information must be provided.

8. A communications plan as well as a process for feedback on the report from major stakeholders (e.g., workshops with other researchers) should be developed.

4.5 Research

A number of information gaps requiring research were identified. Some were common to all groups, others pertained only to a specific contaminant or activity.

1. Research into cause and effect of contaminants, particularly under field conditions was required. Contaminants included organic compounds from urban and municipal wastes, organo-chlorine products in pulp mill effluents, preservatives used in lumber treatment, and metals from mining and smelting operations.

2. The assessment of environmental impacts resulting from multiple discharges and/or non-point source discharges, was a particular problem for urban environments and the mining, agriculture and logging industries.

3. The cumulative effects of small events occurring over longer periods of time needed to be investigated.

4. Information on the toxicity from metal and organic contaminants of bottom sediments is required.

5. The development of water quality objectives for bottom material is required.

6. Monitoring of biological organisms was considered weak in most programs. In addition to body burdens, information on bioaccumulation, toxicity, and ecosystem health is required.

7. The assessment of the temporal trends of toxic compounds which bioaccumulate in biota and the determination of the most sensitive (i.e., efficient) organism and/or tissue for a specific toxic compound should be carried out.

8. Research on the spatial gradients of persistent LRTAP compounds to infer major air mass sources is required.

9. Research into the methods for archiving of biological tissue, sediments, and biota is needed.

10. Research should continue on the use of isotope analysis to help identify the source of a particular contaminant.

11. Long-term monitoring should be coordinated with epidemiological studies when assessing the impacts of water quality.

12. The identification of surrogates for expensive variables is required to help offset escalating analytical costs.

4.6 Training Programs

The lack of trained scientists and technicians already poses limits to existing water quality monitoring programs. This problem may well be exacerbated in coming years as fewer students are enroling in science and engineering programs in schools and universities; university research funding is declining; and existing experienced scientists are retiring. Training for existing staff in the use of new monitoring and analytical techniques such as GIS, statistics, database management, and modelling is urgently needed. Upgrading for staff on risk assessment applications is also a priority.

Scientists and managers need new skills in communicating with the public, particularly in presenting environmental risk assessment information. Training in media and public relations is needed, as well as training in developing materials for the lay reader.

4.7 Institutional Processes

The work groups addressed several concerns relating to the mechanisms governing interaction between government research and regulatory agencies, industry, public surveillance groups, and academic institutions; all collectively described as "stakeholders". The concerns fell into three categories: (1) coordination and cooperation between monitoring agencies collecting data; 2) information exchange between government, industry and the public; and, 3) responsibility for monitoring program design and QA/QC procedures, including the responsibility for funding.

What is most urgent, in the view of many participants, is the need for fundamental changes in procedures practice. This was highlighted by the fact that there are a number of fundamental conflicts including: science vs. law; science vs. public opinion; government scientists vs. government credibility; government vs. industry vs. environmental non-government organizations (ENGO's); needs vs. resource restraints; federal government vs. provincial government; and idealism vs. reality.

It was recognized that resources were presently insufficient, but at the same time increased funding was not likely to be forthcoming. Administrative changes in government, new sources of monies, and cooperative ventures were discussed. It was stressed, however, that the cost of new requirements such as monitoring of sophisticated contaminants cannot be offset by diversion of money from other programs, by automation of analytical techniques, or by down-sizing monitoring requirements, without jeopardizing present objectives. In arguing for resources, the point should be made on the consequences of <u>not</u> obtaining the information.

4.7.1 Program coordination

Each agency collecting water quality data (government, industry, or research institution) has an independent mandate and goal. As there is no coordination of these mandates and goals, there is considerable duplication of data as well as gaps in information. Further, institutional restrictions and incompatibility in databases delay or deny the ready exchange of information.

Lack of sufficient staff, equipment and support services (e.g., funding) was frequently cited as the main impediment to cooperative monitoring programs. Strategies to make monitoring programs more effective were discussed and included:

- the creation of a Canadian water quality institute with input and contributions from government, industry, and university institutions;
- the development of an exchange program with other countries to train and share technical and professional staff;
- the involvement of industry in monitoring beyond end-of-pipe;
- the development of an exchange program between government and industry, whereby government employees are placed in plants to provide environmental consultation; and,
- the establishment of an independent "think-tank" or consulting group that industry can approach to help resolve environmental problems.

4.7.2 Information exchange

The regaining of public trust in environmental monitoring was considered to be crucial, yet it is probably the most difficult to achieve. To improve the situation, a mechanism is required to involve the public early on, and to a much greater degree, in the process.

Improvements in how information is exchanged between the stakeholders are also required. Part of the problem exists due to the various formats of databases used by the different agencies; part is associated with the fact that many agencies are not aware of the existence of monitoring programs; and part is linked with the hierarchical process followed in releasing information.

4.7.3 Responsibility

There was a general agreement among the participants that water quality issues were a shared responsibility between the sources of the contamination, the users of the aquatic systems, and the regulatory agencies. The change in attitude recently, that rivers, lakes, and marine systems are no longer considered a "commons" for effluent discharge was noted. Environmental concerns are recognized as a cost of doing business.

Three options as to how monitoring programs could be regulated and funded were identified.

1. **Government undertakes all aspects of monitoring, from collection to laboratory analysis, to reporting; and funds it directly.**

Two problems exist with this option. One is the lack of adequate personnel and funds within government to carry out all monitoring. The other is the lack of representation by industry and public in the process. There is also some element of distrust of government by both industry and the public.

Another version of this option would be government undertakes all aspects of monitoring and bills industry. Even if industry had sufficient funds to support this, the logistics of managing the technical and professional personnel required to undertake all monitoring programs was viewed as overwhelming. There is also the problem of a lack of control from the industry's perspective on costs or program objectives.

2. **Industry funds and conducts the monitoring program directly or through its consultants.**

One version of this option is for industry to be responsible for program design in total, while the other has government scientists approving of all technical details of the monitoring. This option suits a "user pays" philosophy but extensive involvement by industry in the monitoring will be perceived by some to be in conflict of interest and a strong element of distrust is likely to develop. This option would pose other problems when evaluating long-term and cumulative impacts and multiple discharges. "Close out" monitoring might not be covered under this option.

Some projects, particularly in the mining industry, lack the cash flow during the early stages of development, at a time when critical background information is required. Some mechanism is needed for funding the monitoring until the project

is operating, for example, government conducts monitoring, recovering the costs later through some type of production tax.

3. **Establish a superfund, analogous to the fund for toxic dump restoration in the United States.**

Government and industry would contribute resources, which would be distributed for monitoring programs. There was some discussion as to who would control and distribute the resources, which ranged from total government control to total industry control. The most likely option, however, is the establishment of a joint government-industry committee which would review the scientific merit and establish priorities for funding monitoring programs.

4.8 Economic Considerations

While the focus of the workshop discussions was on the development of new water quality strategies, the discussion also addressed concern about the economic consequences of some of the recommendations, particularly in light of limited budgets. A number of points were raised, including:

1. Attention to economic considerations had to be a part of the initial planning process for water quality programs.

2. All water quality programs should be subjected to cost/benefit analysis and a rationale established for setting priorities.

3. All water quality programs should include the evaluation of the resulting economic impact on the area/industry/business.

5.0 WORKSHOP SUMMARY AND RECOMMENDATIONS

The workshop focused on issues, data gaps and requirements to improve the water quality monitoring and assessment process. In doing so, however, there was a tendency to dwell on negative factors without acknowledging that a lot of excellent programs have been carried out by both federal and provincial government agencies, and that many of the scientists within these agencies are world renown. It would be inappropriate to leave the impression from the workshop that progress in water quality science is stalled.

A case in point is in reference to the activities of the United States Geological Survey, described by the keynote speaker, Mr. Stuart McKenzie. The extensive water quality studies that have been undertaken by the USGS generated a certain degree of envy among the participants. Nevertheless, there are many parallels between the USGS program and work carried out in Canada, federally, provincially and in joint-ventures between the two governments. The Canada-British Columbia Water Quality Monitoring Agreement, which co-sponsored the workshop, is a good example.

The most striking contrast between the efforts in Canada and the USGS is their large commitment of funds to water quality monitoring and assessment. Each basin study, for example, is planned over a ten year period, with a commitment of approximately $4 million.

One aspect of the USGS experience that was highly regarded by workshop participants was their planning and public consultation process. Several years are spent reviewing historical data, collecting preliminary synoptic information, and defining clear objectives for each component of the study. Public involvement was facilitated throughout.

The discussion and networking during the work group and plenary sessions was considered to be the most valuable by the participants. There was a consensus that this exchange, and the resulting commitment by everyone towards improving the water quality monitoring and assessment process, were important outcomes of the workshop.

Data gaps, research requirements and specific monitoring recommendations are identified in the previous section. However, a number of major items, which were highlighted throughout the workshop by all work groups, are presented here.

1. The need to maintain an up-to-date and readily accessible database on water quality.

2. Timely reporting of environmental monitoring to all stakeholders (government, industry and the public).

3. Increased research in targeted areas, especially those likely to have new environmental importance in coming years.

4. Support for training of students, practising scientists, managers and technicians in water quality issues.

5. Support for partnerships between government and industry in all areas of water quality monitoring, including information exchange, planning and funding.

6. Facilitation of active public participation in all stages of the water quality assessment process.

7. Commitments to quality assurance and quality control programs.

One final recommendation supported by those attending, was to repeat the workshop. A variety of potential themes for future workshops were discussed, but most focused on some of the more specific issues and recommendations that resulted from this present workshop. Suggestions included: monitoring programs for specific industry groups; quality assurance/quality control; data management and analysis; and, government/industry/public coordination. There was also a recognition that more public participation in future workshops would be desirable.

Finally, participants were enthusiastic about the benefits of this workshop and considered it a major success.

APPENDIX 1.

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APPENDIX 1: WATER QUALITY WORKSHOP PARTICIPANT LIST

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APPENDIX 2.

WORKSHOP AGENDA

Water Quality Workshop
Plan for the 90's

May 14 - 17, 1990
Island Hall Beach Resort
Parksville, B.C.

PURPOSE

1. To provide a forum for the discussion of significant water quality issues of the 1990s in B.C.

2. To identify the information requirements and develop a model for water quality assessments to address the issues.

THE PARTICIPANTS

Specialists with expertise in water quality assessment have been invited to attend. They come from all parts of British Columbia and from outside the province and include: Representatives from federal and provincial governments together with non-government agencies.

THE FORMAT

Participants will work in small work groups. Each group will discuss a particular water quality issue. Plenary sessions with all participants will review and discuss work group reports.

THE SCHEDULE

Mornings	8:30 to 11:30 a.m.
Noon Break	11:30 a.m. to 1:00 p.m.
Afternoons	1:00 p.m. to 3:30 p.m and
	4:00 p.m. to 6:00 p.m.
Dinner	6:30 p.m.

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Monday, May 14	**7:00 to 9:30 p.m.**	**Registration and Welcome Reception (no host event)** **Organization of Work Groups** **Selection of Work Group Chairs and Rapporteur**

Tuesday, May 15	**Morning**	- Official Welcome and Introduction to work shop - **Keynote Address by:** **Dr. Stewart McKenzie, The United States Geological Survey** **"Evolution of the U.S. Geological Survey Water Quality Programs"** - Questions to Dr. McKenzie - Discussion on monitoring philosophy - Instructions to work groups - Work group discussions begin
	Afternoon	- Concurrent work group sessions continue - Each work group should discuss Topics A, B, and C for their particular issue
	Evening	- Open - Work group chairs and workshop co-ordinators summarize results for presentation next day

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Wednesday, May 16	**Morning**	**Plenary Session** - All participants to respond to summaries of each work group - Work Groups discussions continue
	Afternoon	- Concurrent Work Group Sessions continue - Each Work Group to discuss Topics D and E for their particular issue
	Evening	Barbeque - Island Hall Style! - Work Group Chairs and Workshop Co-ordinators summarize results for presentation next day - Overview of Workshop prepared by Co-ordinators

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Thursday, May 17	**Morning**	**Final Plenary Session** - All participants invited to respond to summaries of each Work Group - Summary and overview of Workshop results - Discussion on how information can be used - Closing Remarks from coordinators (Workshop Evaluation) **WORKSHOP ENDS AT 12 NOON** **ROOM CHECKOUT AND DEPARTURE**

THE WORK GROUPS

There will be five work groups. Each will have six to seven participants.

WORK GROUP I Urbanization and Municipal Discharges

WORK GROUP II Pulp, Paper and Lumber Manufacturing

WORK GROUP III Mining, Smelting and Related Industries

WORK GROUP IV Agriculture and Logging

WORK GROUP V Atmospheric Deposition

Each work group will be responsible for determining the critical issues under each of these categories following the guidelines suggested below. Categories have been kept brief in order to allow the participants to deliberate freely.

THE WORK GROUP FORMAT

Each group made up of six to seven participants will discuss a particular water quality issue(s). Groups will stay together for the duration of the workshop.

Work groups should take a holistic approach to water quality issues, considering all components of the aquatic environment, where appropriate - e.g., surface water, ground water, marine and estuarine waters, precipitation, sediments, and biological organisms - under the general guidelines of:

"WHERE ARE WE NOW?"
"WHERE DO WE WANT TO GO?"
"HOW DO WE WANT TO GET THERE?"
"WHAT RESOURCES DO WE NEED?"

To help work groups in their deliberations, the following five topics are suggested. It is important to note that they are suggestions only, and may not apply for all issues. Discussions do not need to be limited to these topics only; other items for consideration as determined by the work groups will be included.

THE TOPICS

A. Initial Planning

- identification of environmental consequences related to the issue and the specific parameter(s) or contaminants responsible
- identification of the source(s) of contaminants
- quality/quantity of existing information
- identification of information requirements, including major data gaps
- discussion on the purpose(s) for a monitoring/assessment program
- discussion on the need for water quality objectives.

B. Monitoring/Assessment

- type(s) of monitoring/assessments required to meet the purpose of the data collection program
- multi-media sampling, bioassays
- quality control and quality assurance requirements
- analytical limitations
- cost-effectiveness auditing of programs.

C. Data Storage and Handling

- database and database access
- statistical programs
- use of GIS systems

D. Reporting

- comparison with water quality objectives and other criteria
- cumulative impacts (multi-parameter and long-term chronic)
- cause and effect relationships
- relationship with social and health issues
- State-of-Environment reporting requirements
- public input and public information
- identification and assessment of site, regional (watershed) and global impacts
- identification and assessment of event versus continuous impacts

E. Recommendations and Remedial Measures

- limitations to existing approach: legislative, administrative, scientific
- coordination requirements between government, industry, and universities
- technical and financial resources required- overview, placing issue in perspective with other water quality and environmental issues
- roles of government and the private sector for monitoring and assessment.
- strategies for assessing water quality issues

This Event Sponsored By:

The Co-ordinating Committee of the Canada-British Columbia Water Quality Monitoring Agreement

Members

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Secretary	Paul Whitfield, Vancouver

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	Dr. Ron J. Buchanan, Victoria
	Malcolm Clark, Ph.D., Victoria
Secretary	Larry Pommen, Victoria